

## Forest Service Biomass Research & Development Programs

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By  
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Golden, Colorado

## Forest Service - Basics

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- Mission—ensure for present and future generations the long-term health, diversity, and productivity of the land
- Formed 1905, Forest Transfer Act
- Manages 8½% of U.S. land mass or 192 million acres
- Over 30,000 employees, \$3 billion budget, & \$800 million revenues in FY 2000
- Biobased Products Research from 1910 at Forest Products Lab in Madison, WI

## Opportunity Knocks

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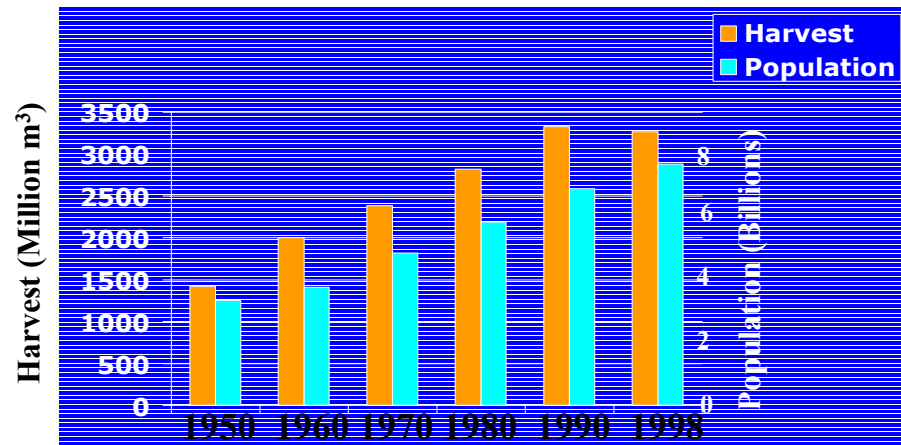
- Most severe fire season in 50 years
- Energy shortages (California)
- Change in political parties in the White House
- Laws encouraging the use of biobased products

## Supply/Demand

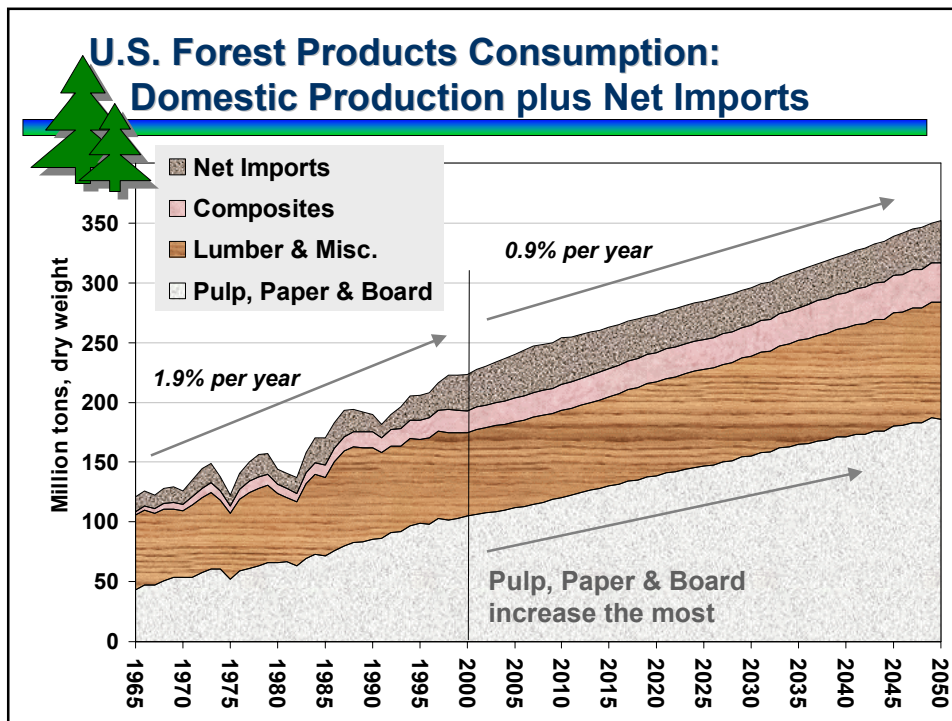
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- Third country in volume of standing timber
- Timber growth still exceeds cut
- Use 25% of all energy generated in the world
- Approximately 3 quads, or 3% is biomass energy, mostly from forest biomass
- Per capita yearly consumption of wood and fiber products in U.S. (2.1 cu. met.) is 4 times world average

## Global Wood Harvest and Population, 1950 to 1998



Source: FAO (2000)



## Our Crowded Forests



Ross' Hole, Montana

1895

1980



## Fire Problems



Seven million acres of  
public land burned in 2000

Funding :\$1.1 billion FS  
FY 2001 :\$0.9 billion DOI



## National Fire Plan

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- Over \$1 billion fighting fires in 2000
- \$1.1 billion additional for Forest Service in FY 2001
  - \$20.5 million for Economic Action Programs and Pilot Projects
  - Potential for forest biomass to energy projects

## Forest Service Biobased Products and Bioenergy Basic Program

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### **Funded at \$9.5 million in FY 2001**

- Growing Feedstock (short rotation)
- Removal (harvesting methods)
- Conversion (lumber, composites, chemicals, energy, pulp, paper)

## Biobased Products and Bioenergy FY 2001 Funding - New

Small Diameter and Low Value Sources  
- \$3 million

■ Products and Utilization	\$1.2M
■ Forest Management	\$1.3M
■ Economics and Social	\$0.5M

## Short Rotation Woody Crop

Hybrid Poplar Plantation  
Potlatch, Corp in Eastern, Oregon



# The Future

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## Priority Research Areas

- New woody cropping systems
- Management, harvest, and utilization of small-diameter timbers
- Products from low value wood-based material
- Technologies for conversion of woody biomass to chemicals, fiber, and composites

## Strategic Partnerships Workshop

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***Forest Service  
Labs Biobased  
Products and  
Bioenergy  
program***

T.W. Jeffries  
Lakewood, Colorado  
April 11-12, 2001

## ***The USDA, Forest Service Forest Products Laboratory***

- Long and distinguished history in the development of biofuels and chemicals
- Record of innovative, problem-solving research
- Excellent analytical and engineering facilities and extensive expertise
- Strong ties to forest managers and the forest products industry



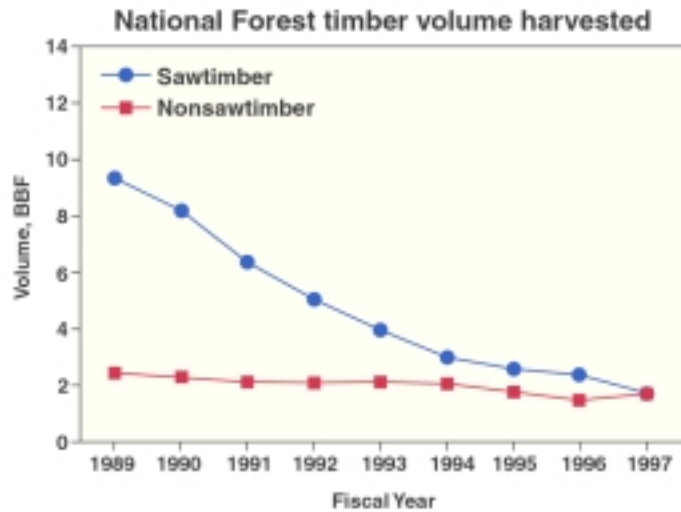
**U.S. Forest Products Laboratory  
Founded in 1910**

### ***Our research has helped establish biobased products as a significant component of our nation's economy***

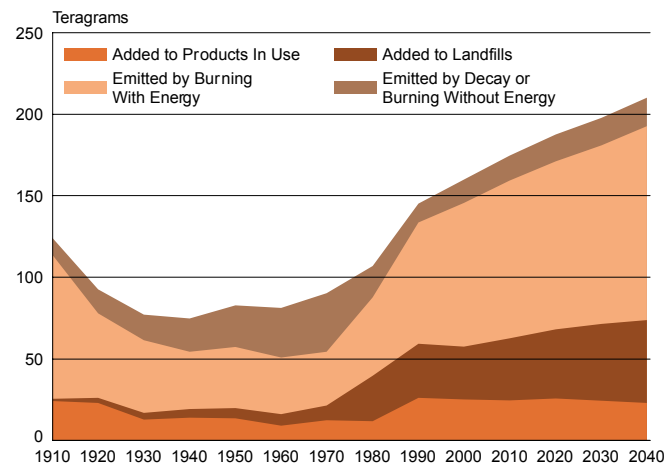
- Paper manufacture -- \$153 billion
- Wood products -- \$98 billion
- Furniture and related -- \$57 billion
- Total of more than \$300 billion annually
- Amounted to 9% of total US manufacturing shipments in 1996



## Recovery of higher value material is declining



## Forest products store carbon after harvest



## ***Higher value products from wood***

- Solid wood products
- Composite products
- Fiber products
- Fuels and chemicals
- Extractive chemicals
- Biopolymer precursors
- Adhesives
- Dissolving pulps
- Pharmaceuticals





Use of arches in  
Contemporary construction



Beams and structural elements  
from fingered segments



## ***New higher value products from wood***

- **Feedstocks do not have appropriate properties for traditional wood products**
- **New products are needed that will enable the economic extraction of low value materials from overstocked stands**
- **Biodegradable paper coatings, fillers, block copolymers, ethanol, polymer precursors**

## ***FPL has a long history with biobased products and bioenergy***

- **Ethanol**
  - 1915-1920
  - 1943-1945
  - 1980-present
- **Chemicals**
  - Extractives
  - Black liquor
  - Lignin chemistry
  - Pharmaceuticals
- **Structural**
  - Plywood, veneer
  - Oriented strand board
  - Laminated structures
  - Composites
- **Paper and fiber board**
  - Recycling
  - Use of hardwood fibers

## ***Conversion technologies***

- **Acid hydrolysis**
  - FPL dilute acid hydrolysis studies
  - Collaboration with TVA
  - NREL pilot plant
- **Enzymatic hydrolysis**
  - FPL research on cellulases
  - Lignin degradation - *Phanerochaete*
- **Pentose fermentation for ethanol**

## ***Our current funding for biobased products***

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- **Use of juniper in western rangelands**
- **Red pine and jack pine thinnings in paper and paperboard**
- **Strength and stiffness of Ponderosa pine**
- **Using small diameter timber in wood fiber/plastic composites**
- **Fermentation of pentose sugars**

## ***Current biobased products***

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- **Small diameter timber**
- **Structural members from underutilized Ponderosa pine**
- **Improved use of red and jack pine in paper and paperboard**
- **Wood fiber-plastic composites**



## ***Current bioenergy***

- Fermentation of five and six carbon sugars by recombinant yeasts
- Metabolic modeling and large-scale engineering of pathways
- Novel enzymes obtained from genomes of biodegradative fungi
- Novel biochemical mechanisms for cellulose decomposition

## ***Future: biorefining***

- ***Current processes yield less than 50%***
- ***High yield process for recovering fiber, chemicals and fuels from wood***
- ***Based on combined chemomechanical, biochemical and extractive recovery***
- ***Obtain highest combined value from feedstock***
- ***Initially focus on separation technologies***

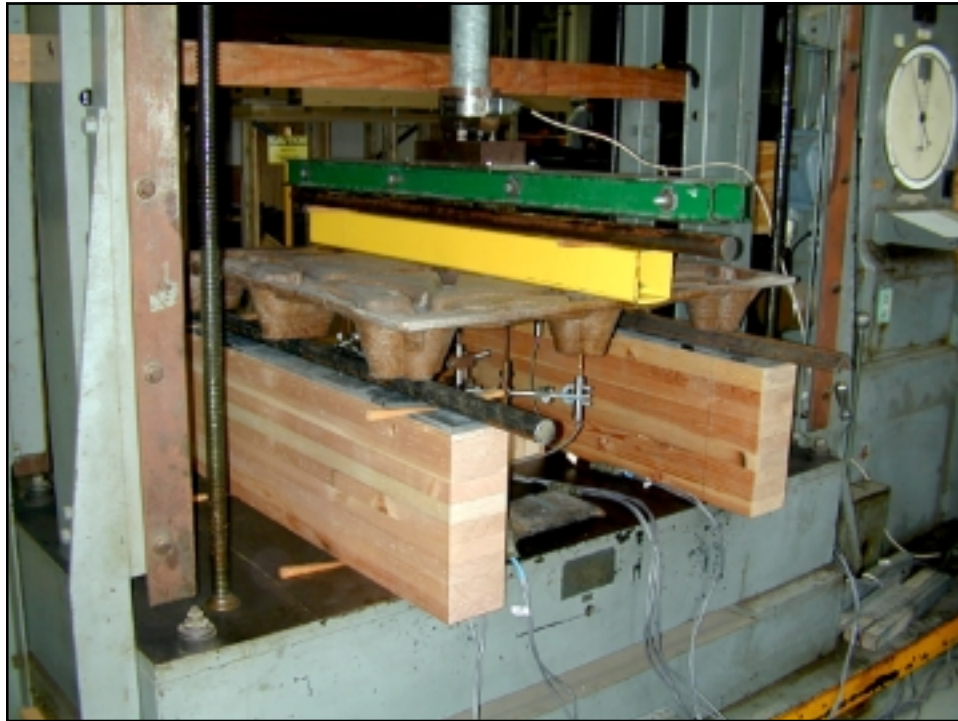
## Analytical and test facilities

- Paper test laboratory
- Complete chemical analysis support
  - GC/MS; HPLC/MS; IR; NMR, Plasma
- Engineering mechanics lab
  - Large scale test machines
  - Frame test facility
  - Composites facilities
- Extensive microbial research collections



Forest Products Laboratory  
Pilot Plant





## Conclusion:

- The Forest Products Laboratory has a long history in biomaterials and bioenergy
- We have an effective, ongoing program
- We have the potential to make significant contributions to the ecological and economical use of biobased products and bioenergy